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Claims

[c1] 1. A method of replacing custom or semi-custom structural components in place on existing structures, the method comprising:
positioning an x-y-z targeting device on an in situ structural component on a structure;
sequentially moving the targeting device to a sufficient plurality of positions on the structural component to define the structure while transmitting x-y-z data from each sequential point to a processor;
designing a substantially similar structural component based upon the transmitted position data; and
fabricating a replica of the structural component from the transmitted information.

[c2] 2. A replacement method according to Claim 1 comprising positioning the targeting device on a metal component of a metal structure, and fabricating a metal replica of the structural component.

[c3] 3. A replacement method according to Claim 1 further comprising the steps of removing the defined structural component from the structure and replacing it with the replica component.

[c4] 4. A replacement method according to Claim 3 comprising:
positioning the targeting device on a riveted metal component of a metal structure;
sequentially moving the targeting device to a sufficient plurality of rivets on the structural component to define the structure while transmitting x-y-z data from each sequential rivet to the processor; and
removing the component from the structure by sequentially removing the rivets as the targeting device is moved thereto.

[c5] 5. A replacement method according to Claim 1 and further comprising sequentially positioning the targeting device at a sufficient number of positions adjacent the perimeter of the component to define the perimeter of the component; and
designing the similar structural component with a defined perimeter based upon the transmitted perimeter data.

[c6] 6. A replacement method according to Claim 4 wherein the step of positioning the targeting device on the metal component comprises positioning the targeting device on a splice plate that joins two or more girders.

[c7] 7. A replacement method according to Claim 4 comprising removing rivets that join at least three plies.

[c8] 8. A replacement method according to Claim 1 wherein the step of positioning the targeting device comprises positioning the targeting device with a gantry.

[c9] 9. A replacement method according to Claim 1 wherein the step of positioning the targeting device comprises positioning the targeting device with an articulating arm.

[c10] 10. A method of replacing riveted metal components in place on existing metal structures, the method comprising:
positioning a rivet removing tool at a rivet on an in situ structural component that is maintained in place by a plurality of rivets;
encoding the position of the rivet removing tool at the rivet and transmitting the encoded position of the rivet to a processor;
removing the rivet;
sequentially moving the rivet removing tool to each of the rivets on the structural component that hold the structural component in place;
sequentially encoding the position of the rivet removing tool at each rivet, transmitting the encoded position of each rivet to the processor, and removing each rivet with

the tool when the tool is at the rivet;
designing a replacement component based upon the encoded positions of the rivets; and
fabricating the replacement component based on the transmitted rivet positions.

[c11] 11. A replacement method according to Claim 10 further comprising the steps of removing the structural component and replacing it with the replacement component.

[c12] 12. A replacement method according to Claim 10 further comprising positioning the rivet removing tool at a plurality of positions on the perimeter of the component to define the perimeter shape of the component;
encoding the position of the rivet removing tool at the respective perimeter positions and transmitting the encoded the positions to the processor; and
designing and fabricating the replacement component with substantially the same perimeter as the original component.

[c13] 13. A replacement method according to Claim 10 comprising removing the rivet using a high-pressure water jet cutting system.

[c14] 14. A replacement method according to Claim 13 comprising including an abrasive in the water jet.

[c15] 15. A replacement method according to Claim 13 comprising including a surfactant in the water jet.

[c16] 16. A replacement method according to Claim 13 comprising including a rust inhibitor in the water jet.

[c17] 17. A replacement method according to Claim 10 wherein the steps of positioning the tool and encoding the position comprise positioning the tool with a coordinate measuring machine.

[c18] 18. A replacement method according to Claim 10 wherein the step of fabricating the replacement comprises fabricating the replacement on a computer numerical control machine.

[c19] 19. A replacement method according to Claim 18 comprising fabricating the replacement on a gantry-based computer numerical control machine selected from the group consisting of plasma arc cutting machines, laser cutting machines, drilling machines, water jet machines, and combinations thereof.

[c20] 20. A replacement method according to Claim 10 wherein the step of fabricating the replacement component comprises painting the replacement component.

[c21] 21. A method of removing a rivet bridging two structural

components with the rivet"s heads on respective first and second opposite faces of the joined components, the method comprising:

directing a water jet having a sufficient pressure to cut the component metal at the perimeter of a rivet on the first face of the joined components;

while vacuum-removing materials from the kerf in the first face that are displaced by the water jet to thereby prevent the displaced materials from being released into the ambient environment;

cutting the component until the water jet penetrates the joined components; and

thereafter vacuum-removing displaced materials from the first and second faces of the joined components until the desired cut is complete to thereby prevent materials displaced from the kerf or from either face from being released into the ambient environment.

[c22] 22. A rivet removal method according to Claim 21 wherein the step of cutting the metal component comprises cutting the component around the shank of the rivet until the rivet is free of the component

23. A rivet removal method according to Claim 22 comprising removing the freed rivet from the component.

[c23] 24. A rivet removal method according to Claim 21 comprising including an abrasive in the water jet to thereby

increase the cutting capacity of the jet.

[c24] 25. A rivet removal method according to Claim 21 wherein the step of vacuum-removing materials from the first face comprises shrouding the first face.

[c25] 26. A rivet removal method according to Claim 21 wherein the step of vacuum-removing materials from the first and second faces comprises shrouding the second face.

[c26] 27. An apparatus for cutting structural components in situ without releasing displaced materials, including lead paint and other potentially hazardous materials, said apparatus comprising:
a water jet cutting head on a first face of a metal structural component for cutting into and through the structural component with the water jet;
a first vacuum head adjacent said cutting head on the first face for removing materials from the first face that are displaced by water jet produced by said cutting head;
a shrouded catcher on the second face of the structural component for absorbing the water jet and displaced materials after the water jet penetrates the structural component;
a second vacuum head adjacent the second face of the component and in shrouded fluid communication with

said catcher for removing the absorbed water and displaced material from the second face of the structural component while preventing the water jet or the displaced materials from being released into the ambient surroundings or environment.

[c27] 28. A cutting apparatus according to Claim 27 comprising:
a magnet on said cutting head for mounting said head to the structural component; and
a magnet on said shrouded catcher for mounting said catcher to the structural component.

[c28] 29. A cutting apparatus according to Claim 28 comprising respective electromagnets on said cutting head and on said shrouded catcher.

[c29] 30. A cutting apparatus according to Claim 28 comprising means for aligning said cutting head on a rivet on the structural component.

[c30] 31. A cutting apparatus according to Claim 27 comprising means for adding an abrasive to the water jet to increase the cutting capability of the water jet.

[c31] 32. A cutting apparatus according to Claim 30 wherein said cutting head is removable detachable from said first vacuum head and wherein said rivet aligning means is

fixed to said first vacuum head.

[c32] 33. A cutting apparatus according to Claim 27 wherein said shrouded catcher is formed of boron carbide, a metal alloy, or a ceramic composite.

[c33] 34. A cutting apparatus according to Claim 27 comprising a common vacuum pump for both vacuum heads.

[c34] 35. A rivet removal tool comprising:
a water jet head having a nozzle;
means for moving said nozzle in three dimensions to a desired targeted position; and
means for pivoting said nozzle at the targeted position along a defined solid sphere so that the pivoting movement of said nozzle compensates the dispersion of the water jet to thereby reduce or eliminate fluting from the resulting hole in a structural component when the rivet is cut free therefrom.

[c35] 36. A rivet removal tool according to Claim 35 comprising means for adding an abrasive to the water jet to increase the cutting capability of the water jet.

[c36] 37. A rivet removal tool according to Claim 35 wherein said nozzle moving means is selected from the group consisting of multi-stage gantries and articulating arms.

[c37] 38. A rivet removal tool according to Claim 35 wherein said pivoting means offsets said nozzle from a main axis and rotates said nozzle about the main axis so that said nozzle can be positioned in the main axis and rotated into any desired angle in a first plane normal to the main axis.

[c38] 39. A rivet removal tool according to Claim 35 wherein the movement of said pivoting means is mechanically fixed based on a defined rivet size.

[c39] 40. A rivet removal tool according to Claim 35 comprising means for aligning said nozzle on a rivet.

[c40] 41. A method of producing a defined cut in a structural component, the method comprising:
moving the nozzle of a water jet cutting device in three dimensions to a desired targeted position on the structural component; and
directing a flow of high pressure water from the nozzle sufficient to cut the component while moving the nozzle in a path that falls on a defined solid sphere to complete a clean substantially cylindrical cut through the component.

[c41] 42. A cutting method according to Claim 41 comprising:
moving the water jet nozzle to a rivet in the structural

component;

piercing the rivet with the water jet; and

making a circular cut in the component around the rivet while moving the nozzle in the path that falls on the defined solid sphere to thereby minimize or eliminate fluting in the resulting circular opening in the component.

[c42] 43. A cutting method according to Claim 42 comprising shrouding the targeted position on the component to prevent material being removed from the component from being released into the ambient environment.

[c43] 44. A cutting method according to Claim 42 comprising shrouding the side of the component opposite the targeted position to prevent material being removed from the component from being released into the ambient environment as the water jet cuts through the component.

[c44] 45. A cutting method according to Claim 43 comprising vacuuming the removed materials from the shrouded targeted position.

[c45] 46. A cutting method according to Claim 44 comprising vacuuming the removed materials from the shrouded opposite side of the component.

[c46] 47. A cutting method according to Claim 42 comprising moving the nozzle using a structure selected from the

group consisting of multi-stage gantries and articulated arms.

[c47] 48. A cutting method according to Claim 42 comprising adding a flow of abrasive to the flow of high pressure water.

[c48] 49. A system for replacing custom or semi-custom structural components in situ and on-site on large structures that should not or can not be fully disassembled, said system comprising:
an encoding coordinate measuring machine for identifying and recording positions to which said measuring device is moved;
means for positioning the coordinate measuring device on a component to be replaced on an existing structure;
means for removing the component from the structure;
a processor in signal communication with said coordinate measuring machine for receiving encoded position information from said measuring machine; and
a computer-numerical-controlled (CNC) cutting machine in signal communication with said processor for producing a replacement component based on information from said processor.

[c49] 50. A component replacement system according to Claim 49 further comprising finishing means for applying a

protective coating to the replacement component.

[c50] 51. A component replacement system according to Claim 50 wherein said finishing means comprises a paint booth and a flash oven.

[c51] 52. A component replacement system according to Claim 49 wherein said coordinate measuring machine includes a support selected from the group consisting of multi-stage gantries and articulating arms.

[c52] 53. A component replacement system according to Claim 49 wherein said component removing means is a rivet removal tool.

[c53] 54. A component replacement system according to Claim 53 wherein said rivet removal tool is a high pressure water jet.

[c54] 55. A component replacement system according to Claim 49 comprising means for moving a replacement piece into place on the existing structure.

[c55] 56. A component replacement system according to Claim 55 comprising a crane.

[c56] 57. A component replacement system according to Claim 49 wherein said processor designs the replacement piece based on the encoded information from said measuring

machine and sends the design of the replacement piece to the CNC cutting machine to thereby produce a substantially identical replica of the removed piece.